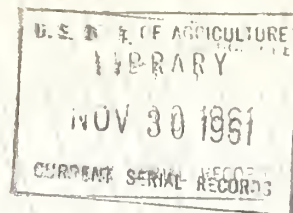


Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

leave
79847W



EVALUATING Delivery Operations of Wholesale Food Distributors

56
U.S. DEPARTMENT OF AGRICULTURE
Transportation & Facilities Research Division

AGRICULTURAL MARKETING SERVICE
Marketing Research Report No. 502

PREFACE

Food distribution firms are confronted with rising costs in their delivery operations. The increases in costs concern not only wholesalers, but also consumers and producers. Increased marketing costs, wherever they occur in the distribution channel, may be reflected in lower returns to growers and higher prices to consumers. This report is part of a broad program of research in the Agricultural Marketing Service aimed at increasing the efficiency of marketing and expanding the markets for farm products.

ACKNOWLEDGMENTS

The following food wholesaler organizations cooperated in this study: P & C Food Markets, Syracuse, N. Y.; Malone and Hyde Co., Memphis, Tenn.; Hale-Halsell Co., Tulsa, Okla.; Springfield Sugar and Products Co., Windsor Locks, Conn.; Godfrey Co., Milwaukee, Wis.; Super Valu Co., Minneapolis, Minn.; The Fleming Co., Kansas City, Kans., and Houston, Tex.; Thriftway Foods, Inc., King of Prussia, Pa.; Washington Wholesale Grocery Co., Washington, D. C.; Virginia Food Distributors, Inc., Richmond, Va.; Armstrong, Inc., Sharon, Pa.; Hannaford Bros., Portland, Maine; Frey and Sons, Inc., Baltimore, Md.; Salley Grocer Co., Shreveport, La.; and M. Loeb, Limited, Ottawa, Canada.

Acknowledgment is made to Robert L. Bull, University of Delaware, and the National-American Wholesale Grocers Association for help in testing the research conclusions. John C. Winter, Chief, Transportation Research Branch, furnished time-study data on delivery operations made by his staff. The study was conducted under the general direction of Raymond W. Hoecker, Chief, Wholesaling and Retailing Research Branch, Transportation and Facilities Research Division, Agricultural Marketing Service.

Washington, D. C.

October 1961

CONTENTS

	<u>Page</u>
Summary.....	4
Introduction.....	5
Developing the normal or standard delivery time.....	5
Time studies.....	6
Charting the factors that affect delivery time.....	7
How to compute normal delivery time.....	10
Using the delivery operation report and the tables.....	21
Percentage difference between actual and normal time.....	22
Evaluating trips with backhaul.....	23
Evaluating trips with a high proportion of perishables.....	24
Conclusions.....	25
Appendix:	
Methodology.....	26
Formulas for estimating normal delivery time.....	26
Case studies.....	32
Checklist of practices to increase efficiency.....	37

SUMMARY

Wholesale food distributors are concerned with means for controlling and evaluating the delivery phase of their operations. U. S. Department of Agriculture researchers have developed a procedure for comparing a firm's overall delivery operation with a standard delivery time and with other firms. The procedure will enable firms to evaluate the performance of individual drivers over most routes. It is based on time-study data covering the many elements that affect delivery trips.

Three principal variables affect delivery time: (1) Number of miles traveled, (2) number of pieces delivered, and (3) number of delivery stops made. The research established time units for each of these factors in different kinds of trips: (1) The time to drive a mile in urban and nonurban trade territories and in trips of varying distances; (2) the time to unload and check a case of merchandise for different sizes of orders and at stores having various facilities; and (3) the time to make each delivery stop, including the average time necessary to conduct business with retailers.

These time units are set forth in tables with which wholesalers can easily compute the time required for making almost any grocery delivery trip to retail food stores. Adjustments are made for trips in which backhauls are made from the supplier and those in which more than 10 percent of the pieces are perishables.

A group of leading wholesale food distributors tested the procedure and found it to be accurate and effective for evaluating and controlling delivery operations.

^{3a}
~~2~~ By Charles ²Crossed and Martin Kriesberg //
Agricultural Marketing Service 1/

INTRODUCTION

Delivery costs are 20 to 25 percent of the total expenses of wholesale food distributors; therefore, savings in this function can affect overall food distribution costs. Controlling delivery costs has been difficult because there have been no standards of performance for delivery drivers and no generally accepted standards for comparison among wholesale grocers. Since delivery operations are not closely supervised, other measures for control are needed.

This report describes a procedure for evaluating the performance of drivers; it tells how the procedure was developed, and how it may be used by distributors to improve the efficiency of their delivery operation. The study on which this report is based is part of a broad program of research designed to reduce costs of marketing agricultural commodities.

Wholesale food distributors have used many devices, such as driver logs and mechanical recorders of truck movement, to control delivery operations. These devices give information about the driver and the route, but they do not measure performance or efficiency. Some wholesalers use operating ratios to evaluate and control their deliveries. Among the most commonly used ratios are tons delivered per man-hour and cost per ton-mile. When these operating ratios are used for a long time, they may show trends for a company (if there are no major changes in the delivery operation). However, wide differences in trade and territory served by different firms limit the usefulness of such ratios for interfirm and interbranch comparisons.

The procedure in this report enables wholesale food distributors to evaluate the performance of individual drivers over most routes. It also permits an evaluation of a firm's overall delivery operation against normal delivery time, and, hence, facilitates comparison between firms. The normal or standard, as used here, is the performance that a conscientious driver, working with average skill and at an average pace, can attain.

DEVELOPING THE NORMAL OR STANDARD DELIVERY TIME

Delivery time varies directly with three major factors: (1) Number of miles traveled, (2) number of pieces delivered, and (3) number of delivery stops made. Each of these factors is affected by other variables.

1/ The authors are now members of the Marketing Economics Division, Economic Research Service, U. S. Department of Agriculture.

Time Studies

Precise measurements of each of the three factors were obtained through time studies. 2/ Researchers made approximately 15 trips with each of 8 whole-sale grocery firms in various parts of the country. The average size of orders delivered by these companies ranged from 18 pieces per stop to over 1,000 pieces per stop; the average distance traveled per trip ranged from 41 miles to over 200 miles; the average number of stops ranged from 1 to 19 per trip. Since the studies covered a variety of firms--including small and large wholesale grocers, rural and urban firms, and those serving small and large stores--it was possible to chart the results of the time studies for each of the major variables.

In addition to the 120 trips time-studied, detailed data were obtained from 7 other companies covering 10 warehouses and several hundred additional trips. This permitted testing the results of the studies against companies with delivery characteristics which, in a few instances, were different from those time-studied. The data in this report, therefore, reflect the operations of 15 wholesalers and over 800 delivery trips in all parts of the country.

The time studies included all of the usual activities of a grocery delivery driver in his relationship with store operators. The driver unloads the truck, usually into the backroom; he may collect for the merchandise, and, in most cases, waits for the merchandise to be checked. The time studies did not include operations in which the merchandise is price-marked as it is being checked in (causing the driver greater delay), or pallet unloading at the retail store (which reduces unloading time). They did not include operations in which the driver put merchandise on shelves or made out the retailer's next order. Trips which include these factors should not be used in evaluating deliveries by the method given in this report.

In the time studies, the job of delivering merchandise was broken down into its elements; these were timed and rated. Each of the driver's activities, except driving and unavoidable delays, was rated to yield the time a competent operator, working at normal speed, would take to perform the same activity. The elements were then combined to show the time required for the major parts of a delivery trip, such as getting ready to unload, and unloading a case of merchandise.

The three major factors were analyzed to determine their relationship to each other and to the total delivery time. The average time for each of these three variables was computed for each trip and then studied. The time for traveling a mile, unloading a case, and making a delivery stop varied with distance between stops, total miles traveled, and number of pieces per stop. The variables were not directly related. For instance, the average unload time per piece was much less when the average order per stop was over 500 cases than when it was under 100 cases. Similarly, the time per mile traveled was less when the trip was longer and the average number of miles per stop increased.

2/ Preliminary research was done by multiple correlation and is reported by Martin Kriesberg in "Procedures for Measuring Employee Productivity," Advanced Management, August 1952.

Charting the Factors That Affect Delivery Time

The three major variables that affect delivery time were charted and the slope of each curve is explained below.

Time for Driving

More than 10,000 miles were traveled in the 120 delivery trips that were time-studied. The distance per trip ranged from 40 miles to over 200 miles, and the distance per stop ranged from 5 to 200 miles. A direct relationship was found between travel time and the average number of miles per stop. Total miles traveled also affected the travel time. The travel time from the time studies was charted, by total miles traveled, in a scatter diagram. ^{3/} Figure 1 shows the relationship between travel time per mile and the total distance traveled for trips of 91 to 200 miles.

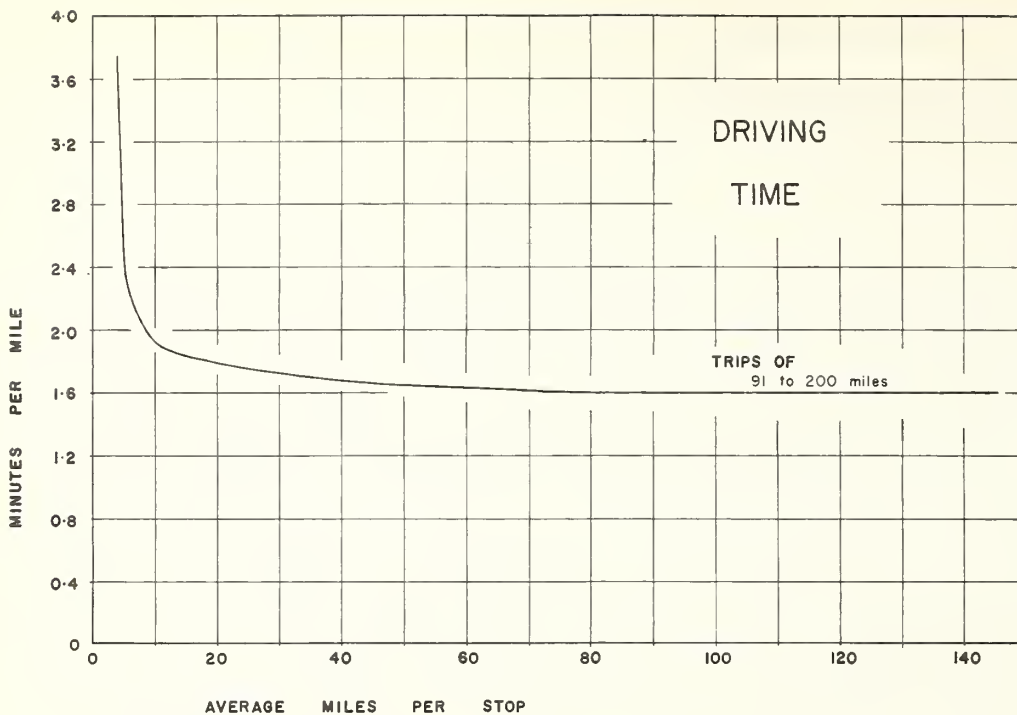
The total distance affects travel time because the trip back to the warehouse, after the last delivery, is seldom interrupted. In the research, lines similar to that in figure 1 were drawn for trips under 91 miles and over 200 miles. When the total distance is under 91 miles, the travel at the end of the trip is usually from about 5 miles to a maximum of 45 miles; when the total is from 91 to 200 miles, the travel back to the warehouse is normally longer (from 20 to 100 miles); and when the total trip is over 200 miles, the distance back to the warehouse is longer still. Expressways and other high-speed highways can be used when the distance between stops or back to the warehouse is great; hence, the distance can be covered in less time per mile.

Figure 1 shows that the travel time per mile decreases as the average number of miles per stop increases. When the average number of miles per stop increases above 10 miles, the decrease in travel time per mile is more gradual than when the average is less than 10 miles. A large proportion of travel time is required for starting and parking; this factor is not significant when most of the time is spent in traveling between stops. Also, when the distance is short between stops, the trip is usually being made in heavily populated areas with more traffic and slower driving speeds.

Time for Unloading and Checking Merchandise

In the 120 delivery trips that were time-studied, over 80,000 pieces of merchandise were unloaded at 1,400 retail stores. The time to unload grocery merchandise varied with the number of pieces per stop. The average unloading time per piece (total unloading time for a delivery trip, divided by the number of pieces delivered) was charted against the average number of pieces per order (total pieces delivered, divided by number of delivery stops) to determine the exact relationship. This relationship, based on a scatter diagram, is shown in figure 2.

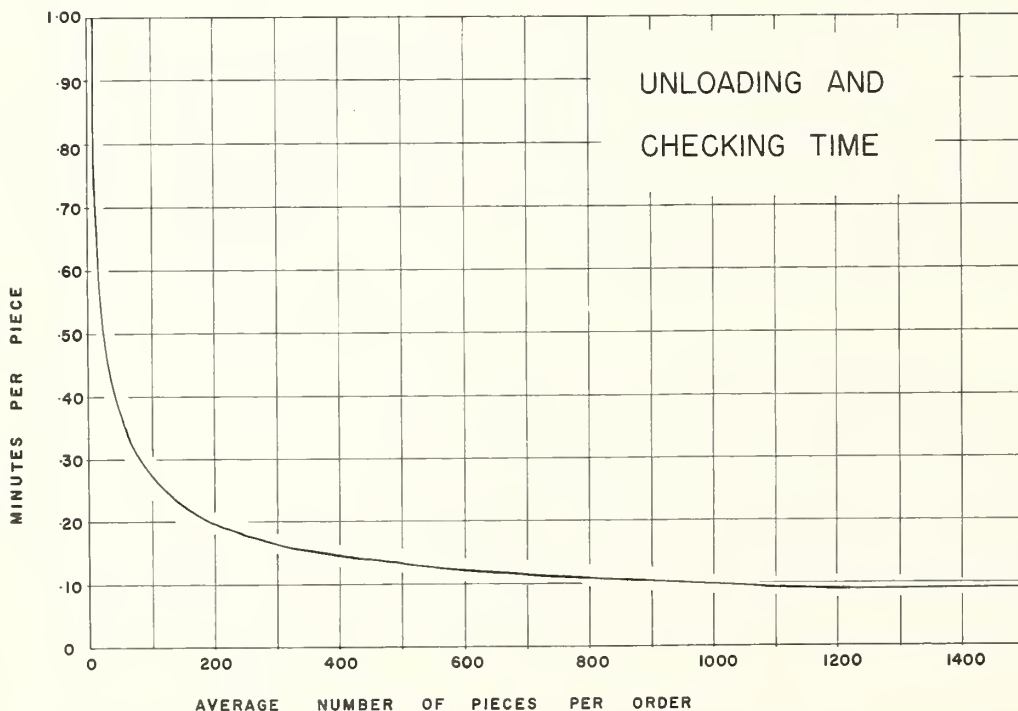
^{3/} See section on research methodology in the appendix for details of this procedure.



U. S. DEPARTMENT OF AGRICULTURE

8379-61(1) AGRICULTURAL MARKETING SERVICE

Figure 1.--Average driving time per mile for grocery delivery trips to retail stores in nonurban areas.



U. S. DEPARTMENT OF AGRICULTURE

8380-61(1) AGRICULTURAL MARKETING SERVICE

Figure 2.--Average unloading time per piece for groceries delivered to retail stores in nonurban areas.

As indicated by figure 2, less time is required to unload a case of merchandise in a large order than in a small order. When the average order is less than 10 cases, the unloading time is nearly 1 minute per piece. When the average order is 1,000 cases or more, the unloading time decreases to less than one-tenth minute per piece. The difference in unloading time results from differences in the facilities and methods used to unload large and small orders and in the kind of help that retailers give the truck drivers. Researchers found that most stores receiving large orders had good receiving space and facilities and often had personnel to help the driver unload. Stores that received large orders almost always used conveyors. (Pallet unloading was not used in the firms studied.) The large orders were almost always charged, and there was no need for the driver to collect money or give receipts. Large orders were checked by piece count or item check while the merchandise was unloaded, rather than while the driver waited.

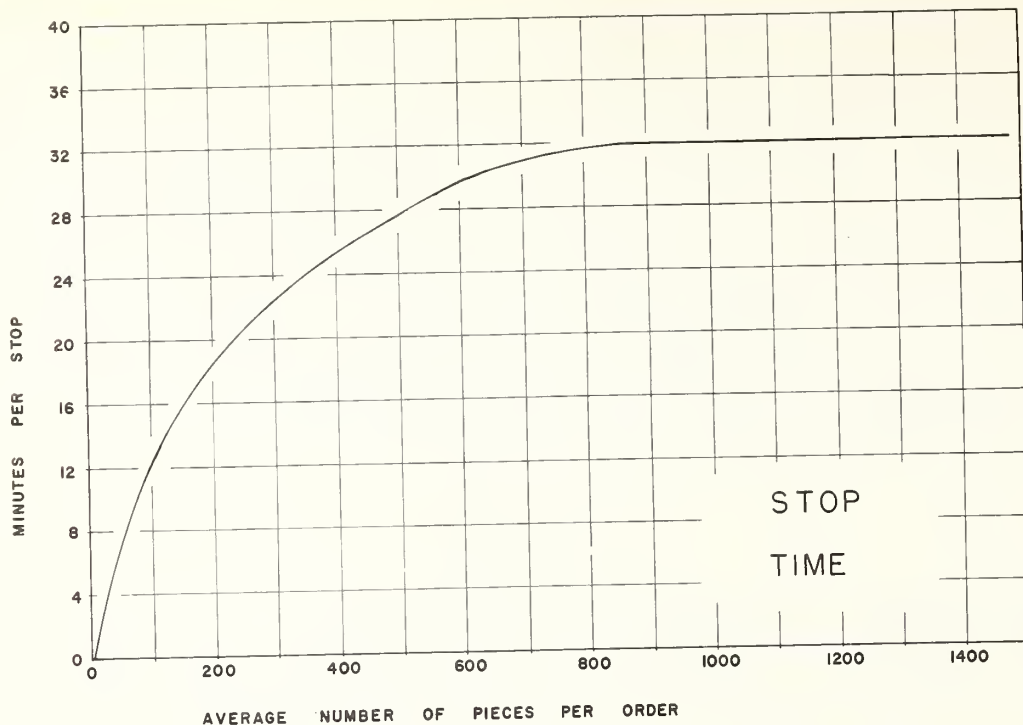
Stop Time

At each delivery stop, there is a small amount of time that is not included in either unloading and checking time or travel time. It is referred to in this report as "stop time." This time includes such activities as preparing to unload the truck, receiving instructions from the retailer, filling out information on the delivery manifest, and, when necessary, collecting for orders. Also included is unavoidable delay time at each delivery stop, such as waiting for dock space and waiting for the retailer to open the receiving door and sign the invoice. It also includes time the driver spends in conversation with the retailer when the conversation seems necessary to the delivery. (The precise time-study elements covered by stop time are given in the appendix.)

Stop time was analyzed in the same way the other two variables were; the significant relationship appears in figure 3. This figure shows that the stop time increases as the number of pieces in an order increases. 4/

Preparing to unload and preparing to leave are the most important items in this variable. These two items account for about 65 percent of this variable time and explain the slope of the curve in figure 3. When the order size is small (under 50 pieces), the stop time is less than 8 minutes. This is because there is very little preparation to unload or to leave when small orders are delivered at small stores. The merchandise is usually taken in the front of the store on a two-wheel cart and moved to the backroom. On the other hand, large stores must set up conveyors to receive orders (prepare to unload) and remove conveyors (prepare to leave) when unloading is completed. Although the facilities of stores that receive large orders are more efficient, reducing the unloading time per piece, a longer stop time is required for preparing to unload and then preparing to leave.

4/ This variable is statistically less reliable than the other two because it contains a variety of items and occurs irregularly from trip to trip. However, like the other variables charted, this line represents an average and, since trips are evaluated in groups, wide departures from the average should not be encountered.



U. S. DEPARTMENT OF AGRICULTURE

8481-61(1) AGRICULTURAL MARKETING SERVICE

Figure 3.--Average stop time (for activities other than unloading and checking) required to deliver groceries to retail stores in nonurban areas.

HOW TO COMPUTE NORMAL DELIVERY TIME

The information necessary to find the normal delivery time for any trip is relatively easy to obtain. Much of the information is available before the trip is run; the only information about each trip that must be obtained after the trip is completed is the total miles traveled. The following information is needed: (1) Number of pieces delivered (grocery and perishables); (2) number of delivery stops; and (3) total miles traveled.

The delivery operation report (fig. 4) provides space for all of the information needed and for the computations necessary to arrive at the normal delivery time. This form consolidates all of the information on one page so actual and normal delivery times can be readily compared. The form is designed to facilitate evaluation of each driver; the overall delivery operation can be evaluated by summarizing the results from all the drivers.

When the needed information has been entered in the report, tables 1 to 6 can be used to find the normal travel time, unload time, and stop time for the trip. ^{5/} Tables 1 to 3 (nonurban trips) are used for deliveries in and around small towns. Tables 4 to 6 (urban trips) are used for trips in and around metropolitan areas.

^{5/} Tables 9 and 10 in the appendix give the formulas used to determine the normal times shown in tables 1 to 6.

FOUR WEEK DELIVERY OPERATION REPORT

DRIVER J. Smith

DATE	TIME LEAVING W' HSE	TIME RET. TO DEL. TIME	① ODOMETER READ			② TOTAL MILES OF TRIP	③ NO. OF DEL. STOPS	④ AVER. MILES PER STOP	⑤ NO. OF PIECES DEL'D	⑥ AVER. ORDER SIZE	⑦ RURAL OR URBAN	⑧ COMPUTED DEL. TIME			⑨ ACTUAL DEL. TIME	
			FINISH TRIP	START TRIP	MILES							TRAVEL TIME	NORMAL UNLOAD TIME	NORMAL STOP TIME		minutes
Jan 10 '41	7:00am	6:00pm	32,588	32,378	210	3	70	1300	433	Rural		336	182	80	598	600
(about 20 lines)																

① Deduct lunch time and any time allowed for "breaks" before entering this figure

② Odometer reading at end of trip minus odometer reading when truck leaves warehouse at beginning of trip

③ Total miles travelled divided by number of delivery stops

④ Pieces of merchandise should be listed - If more than 10% of merchandise is perishable, pieces should be listed in a separate column; see APPENDIX for method of making adjustment

⑤ Number of pieces delivered divided by number of delivery stops

⑥ Note type of trip - use proper estimating table

⑦ Estimated time is computed and listed in these columns

⑧ Convert ACTUAL DEL. TIME (①) to minutes and list

TOTAL DELIVERY TIME

DIFFERENCE FROM NORMAL DEL. TIME

% DIFFERENCE FROM NORMAL DEL. TIME

Figure 4.--Delivery operation report form for wholesale grocers. The report covers a 4-week period.

Table 1.--Normal driving times, nonurban delivery trips by wholesale grocers

Total miles	Average distance per stop									
	Over	6.1 to	5.1 to	6 miles	5.1 miles	Under	6.1 to	5.1 to	6.0 miles	5.1 to
	11.0 miles	11 miles	11 miles	6 miles	5.1 miles	Under	6.1 to	5.1 to	6.0 miles	5.1 miles
A--For trips of less than 90 miles:	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
Under 20.....	23	24	27	27	30	30				
20 to 30.....	57	60	67	67	75	75				
31 to 40.....	80	84	94	94	105	105				
41 to 50.....	103	108	121	121	135	135				
51 to 60.....	126	132	148	148	165	165				
61 to 70.....	149	156	175	175	195	195				
71 to 80.....	172	180	202	202	225	225				
81 to 90.....	195	204	230	230	255	255				
B--For trips of 91 to 200 miles:	Over	26 to	12.1 to	25 miles	12.0 miles	8.1 to	6.1 to	5.1 to	5.1 miles	Under
90 to 100.....	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
90 to 100.....	152	162	171	171	180	180	200	218	256	256
101 to 110.....	168	178	189	189	200	200	220	242	284	284
111 to 120.....	184	195	207	207	218	218	241	264	310	310
121 to 130.....	200	212	225	225	238	238	262	288	338	338
131 to 140.....	216	230	243	243	256	256	283	310	365	365
141 to 150.....	232	246	261	261	275	275	304	333	392	392
151 to 160.....	248	264	279	279	294	294	325	356	418	418
161 to 170.....	264	280	297	297	313	313	346	380	445	445
171 to 180.....	280	298	315	315	332	332	368	402	472	472
181 to 190.....	296	314	333	333	352	352	388	425	500	500
191 to 200.....	312	332	351	351	370	370	410	448	526	526

C--For trips over	Over	51 to	26 to	Under
200 miles:	110 miles:	110 miles:	50 miles:	26 miles
	Min.	Min.	Min.	Min.
201 to 210.....	308	328	348	319
211 to 220.....	322	344	365	387
221 to 230.....	338	360	382	405
231 to 240.....	352	376	400	423
241 to 250.....	368	392	416	441
251 to 260.....	382	408	434	459
261 to 270.....	398	424	450	477
271 to 280.....	412	440	468	495
281 to 290.....	428	456	484	513
291 to 300.....	442	472	501	531
301 to 310.....	450	488	518	549
311 to 320.....	472	504	535	567
321 to 330.....	488	520	553	585
331 to 340.....	502	536	570	603
341 to 350.....	518	552	586	621
351 to 360.....	532	568	603	639
361 to 370.....	548	584	620	657
371 to 380.....	562	600	638	675
381 to 390.....	578	616	655	693

Table 2.--Normal unloading and checking times, nonurban delivery trips by wholesale grocers

Total number of pieces delivered	Average order per stop															
	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
200 to 225...																
226 to 250...																
251 to 275...																
276 to 300...																
301 to 325...																
326 to 350...																
351 to 375...																
376 to 400...																
401 to 425...																
426 to 450...																
451 to 475...																
476 to 500...																
501 to 525...																
526 to 550...																
551 to 575...																
576 to 600...																
601 to 625...																
626 to 650...																
651 to 675...																
676 to 700...																
701 to 725...																
726 to 750...																
751 to 775...																
776 to 800...																

801 to 825...	85	98	102	114	126	146	179	207	236	272	:
826 to 850...	88	100	105	117	130	151	184	214	243	281	:
851 to 875...	91	104	108	121	134	155	190	220	250	289	:
876 to 900...	93	106	111	124	138	160	195	226	258	297	:
901 to 925...	96	110	114	128	142	164	201	233	265	306	:
926 to 950...	98	112	117	131	145	169	206	239	272	314	:
951 to 975...	101	116	120	135	149	173	212	245	279	323	:
976 to 1,000:	104	118	124	138	153	178	217	252	286	331	:
1,001 to 1,025:	106	122	127	142	157	182	223	258	294	339	:
1,026 to 1,050:	109	124	130	145	161	187	228	265	301	:	:
1,051 to 1,075:	96	128	133	149	165	191	234	271	308	:	:
1,076 to 1,100:	98	130	136	152	169	196	239	277	315	:	:
1,101 to 1,125:	100	134	139	156	172	200	245	284	323	:	:
1,126 to 1,150:	102	136	142	159	176	205	250	290	330	:	:
1,151 to 1,175:	105	140	145	163	180	209	256	297	337	:	:
1,176 to 1,200:	107	142	149	166	184	214	261	303	344	:	:
1,201 to 1,225:	109	146	152	170	188	218	267	309	352	:	:
1,226 to 1,250:	111	148	155	173	192	223	272	316	359	:	:
1,251 to 1,275:	114	152	158	177	196	227	278	322	366	:	:
1,276 to 1,300:	116	154	161	180	200	232	283	328	374	:	:
1,301 to 1,325:	118	158	164	184	204	236	289	335	:	:	:
1,326 to 1,350:	120	160	167	187	207	241	294	341	:	:	:
1,351 to 1,375:	123	164	170	191	211	245	300	348	:	:	:
1,376 to 1,400:	125	166	174	194	215	250	305	354	:	:	:
1,401 to 1,425:	127	170	177	198	219	254	311	360	:	:	:
1,426 to 1,450:	129	172	180	201	223	258	316	367	:	:	:
1,451 to 1,475:	132	176	183	205	227	263	322	373	:	:	:
1,476 to 1,500:	134	178	186	208	231	267	327	379	:	:	:
1,501 to 1,525:	136	:	:	:	:	:	:	:	:	:	:
1,526 to 1,550:	138	:	:	:	:	:	:	:	:	:	:

Table 3.--Normal stop times, nonurban delivery trips by wholesale grocers

Total delivery stops	Average order size														
	Over	601 to: 501	to: 401	to: 301	to: 201	to: 126	to: 101	to: 76	to: 51	to: 26	to: 10	to	pieces:	pieces:	pieces:
	700	700	600	500	400	300	200	125	100	75	50	25	pieces:	pieces:	pieces:
	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.	Min.
1.....	32	30	28	26	24	19	16	14	10	6	4	3			
2.....	64	61	57	53	48	38	32	27	20	12	7	6			
3.....	96	92	86	80	72	57	48	40	30	18	10	8			
4.....			114	106	96	76	64	54	40	24	14	11			
5.....				132	120	95	80	68	50	30	18	14			
6.....						114	96	81	60	36	21	17			
7.....															
8.....						133	112	94	70	42	24	20			
9.....						152	128	108	80	48	28	22			
10.....							144	121	90	54	32	25			
11.....															
12.....							160	135	100	60	35	28			
13.....							176	148	110	66	38	31			
14.....								162	120	72	42	34			
15.....															
16.....								176	130	78	46	36			
17.....									140	84	49	39			
18.....									150	90	52	42			
19.....															
20.....									160	96	56	45			
21.....									170	102	60	48			
22.....									180	108	63	50			
23.....															
24.....									190	114	66	53			
25.....									200	120	70	56			
										126	74	59			
										132	77	62			
										138	80	64			
										144	84	67			
										150	88	70			

Table 4.--Normal driving times, urban delivery trips by wholesale grocers

Total miles	Average distance per stop					
	Over	3.1 to	2.1 to	1.6 to	Under	
	4 miles	4.0 miles	3.0 miles	2.0 miles	1.5 miles	
	<u>Min.</u>	<u>Min.</u>	<u>Min.</u>	<u>Min.</u>	<u>Min.</u>	
4 to 6.....	17	18	20	24	35	
6.1 to 8.....	24	24	28	34	49	
8.1 to 10.....	31	32	36	43	63	
10.1 to 12.....	37	38	44	53	77	
12.1 to 14.....	44	46	52	62	91	
14.1 to 16.....	51	52	60	72	105	
16.1 to 18.....	58	60	68	82	119	
18.1 to 20.....	65	66	76	91	133	
20.1 to 22.....	71	74	84	101	147	
22.1 to 24.....	78	80	92	110	161	
24.1 to 26.....	85	88	100	120	175	
26.1 to 28.....	92	92	108	130	189	
28.1 to 30.....	99	100	116	139	203	
30.1 to 32.....	105	106	124	149	217	
32.1 to 34.....	112	114	132	158	231	
34.1 to 36.....	119	120	140	168	245	
36.1 to 38.....	126	128	148	178	259	
38.1 to 40.....	133	134	156	187	273	
40.1 to 42.....	139	142	164	197		
42.1 to 44.....	146	150	172	206		
44.1 to 46.....	153	156	180	216		
46.1 to 48.....	160	164	188	226		
48.1 to 50.....	167	172	196	235		
50.1 to 52.....	173	180	204			
52.1 to 54.....	180	186	212			
54.1 to 56.....	187	194	220			
56.1 to 58.....	194	200	228			
58.1 to 60.....	201	208	236			
60.1 to 62.....	207	214	244			
62.1 to 64.....	214	220	252			
64.1 to 66.....	221	228	260			
66.1 to 68.....	228	234				
68.1 to 70.....	235	242				

Table 5.--Normal unloading and checking times, urban delivery trips by wholesale grocers

		Average pieces per order															
Total		Over : 651 to: 850		: 851 to: 151		: 151 to: 251		: 251 to: 351		: 351 to: 451		: 451 to: 551		: 551 to: 651		: 651 to: 751	
pieces		pcs.	Min.	pcs.	Min.	pcs.	Min.	pcs.	Min.	pcs.	Min.	pcs.	Min.	pcs.	Min.	pcs.	Min.
200 to 225...																	
226 to 250...																	
251 to 275...																	
276 to 300...																	
301 to 325...																	
326 to 350...																	
351 to 375...																	
376 to 400...																	
401 to 425...																	
426 to 450...																	
451 to 475...																	
476 to 500...																	
501 to 525...																	
526 to 550...																	
551 to 575...																	
576 to 600...																	
601 to 625...																	
626 to 650...																	
651 to 675...																	
676 to 700...																	
701 to 725...																	
726 to 750...																	
751 to 775...																	
776 to 800...																	

Table 6.--Normal stop times, urban delivery trips by wholesale grocers

Total delivery stops	Average pieces per order															
	Over : 651 to: 850 : pieces:	651 to: 850 : pieces:	451 to: 650 : pieces:	351 to: 450 : pieces:	251 to: 350 : pieces:	151 to: 250 : pieces:	101 to: 150 : pieces:	71 to: 100 : pieces:	51 to: 70 : pieces:	31 to: 50 : pieces:	26 to: 30 : pieces:	21 to: 25 : pieces:	16 to: 20 : pieces:	11 to: 15 : pieces:	6 to: 10 : pieces:	Under 6 : pieces:
1.....	Min. : 22 : 44	Min. : 21 : 42	Min. : 20 : 40	Min. : 19 : 38	Min. : 18 : 36	Min. : 17 : 34	Min. : 16 : 32	Min. : 12 : 24	Min. : 9 : 18	Min. : 7 : 14	Min. : 6 : 12	Min. : 5 : 10	Min. : 4 : 8	Min. : 3 : 6	Min. : 2 : 4	Min. : 1 : 3
2.....	Min. : 44 : 63	Min. : 42 : 60	Min. : 40 : 57	Min. : 38 : 54	Min. : 36 : 51	Min. : 34 : 48	Min. : 32 : 46	Min. : 24 : 36	Min. : 18 : 27	Min. : 14 : 21	Min. : 12 : 18	Min. : 10 : 15	Min. : 8 : 12	Min. : 6 : 9	Min. : 4 : 7	Min. : 3 : 5
3.....	Min. : 63 : 80	Min. : 60 : 76	Min. : 57 : 72	Min. : 54 : 68	Min. : 51 : 64	Min. : 48 : 60	Min. : 46 : 56	Min. : 36 : 48	Min. : 27 : 36	Min. : 21 : 28	Min. : 18 : 24	Min. : 15 : 20	Min. : 12 : 16	Min. : 9 : 12	Min. : 6 : 8	Min. : 4 : 5
4.....	Min. : 80 : 108	Min. : 76 : 102	Min. : 72 : 96	Min. : 68 : 88	Min. : 64 : 84	Min. : 60 : 78	Min. : 56 : 72	Min. : 48 : 60	Min. : 36 : 48	Min. : 28 : 36	Min. : 24 : 30	Min. : 20 : 25	Min. : 16 : 20	Min. : 12 : 15	Min. : 8 : 10	Min. : 5 : 7
5.....	Min. : 108 : 136	Min. : 102 : 126	Min. : 96 : 119	Min. : 88 : 108	Min. : 84 : 102	Min. : 80 : 96	Min. : 76 : 92	Min. : 60 : 72	Min. : 48 : 56	Min. : 36 : 44	Min. : 30 : 36	Min. : 25 : 30	Min. : 20 : 24	Min. : 15 : 18	Min. : 10 : 12	Min. : 7 : 9
6.....	Min. : 136 : 164	Min. : 126 : 152	Min. : 119 : 144	Min. : 108 : 132	Min. : 102 : 126	Min. : 96 : 120	Min. : 92 : 116	Min. : 72 : 84	Min. : 56 : 68	Min. : 44 : 56	Min. : 36 : 48	Min. : 30 : 36	Min. : 24 : 30	Min. : 18 : 21	Min. : 12 : 15	Min. : 8 : 10
7.....	Min. : 164 : 192	Min. : 152 : 180	Min. : 144 : 172	Min. : 132 : 160	Min. : 126 : 154	Min. : 120 : 148	Min. : 116 : 144	Min. : 96 : 112	Min. : 84 : 100	Min. : 72 : 88	Min. : 60 : 72	Min. : 50 : 60	Min. : 40 : 48	Min. : 30 : 36	Min. : 20 : 24	Min. : 15 : 18
8.....	Min. : 192 : 220	Min. : 180 : 208	Min. : 172 : 200	Min. : 160 : 188	Min. : 154 : 182	Min. : 148 : 176	Min. : 144 : 172	Min. : 120 : 144	Min. : 100 : 124	Min. : 88 : 112	Min. : 78 : 102	Min. : 65 : 85	Min. : 52 : 68	Min. : 40 : 52	Min. : 30 : 40	Min. : 20 : 30
9.....	Min. : 220 : 248	Min. : 208 : 236	Min. : 200 : 228	Min. : 188 : 216	Min. : 182 : 210	Min. : 176 : 204	Min. : 172 : 200	Min. : 144 : 168	Min. : 124 : 148	Min. : 112 : 136	Min. : 102 : 126	Min. : 85 : 105	Min. : 72 : 92	Min. : 52 : 72	Min. : 40 : 60	Min. : 30 : 50
10.....	Min. : 248 : 276	Min. : 236 : 264	Min. : 228 : 256	Min. : 216 : 244	Min. : 210 : 238	Min. : 204 : 232	Min. : 200 : 228	Min. : 168 : 192	Min. : 148 : 172	Min. : 136 : 160	Min. : 126 : 150	Min. : 105 : 125	Min. : 92 : 112	Min. : 72 : 92	Min. : 60 : 80	Min. : 50 : 70
11.....	Min. : 276 : 304	Min. : 264 : 292	Min. : 256 : 284	Min. : 244 : 272	Min. : 238 : 266	Min. : 232 : 260	Min. : 228 : 256	Min. : 192 : 216	Min. : 172 : 196	Min. : 160 : 184	Min. : 150 : 174	Min. : 125 : 145	Min. : 112 : 132	Min. : 92 : 112	Min. : 80 : 100	Min. : 70 : 90
12.....	Min. : 304 : 332	Min. : 292 : 320	Min. : 284 : 312	Min. : 272 : 300	Min. : 266 : 294	Min. : 260 : 288	Min. : 256 : 284	Min. : 216 : 240	Min. : 196 : 220	Min. : 184 : 208	Min. : 174 : 200	Min. : 145 : 165	Min. : 132 : 152	Min. : 112 : 132	Min. : 100 : 120	Min. : 90 : 110
13.....	Min. : 332 : 360	Min. : 320 : 348	Min. : 312 : 340	Min. : 300 : 328	Min. : 294 : 322	Min. : 288 : 316	Min. : 284 : 312	Min. : 240 : 264	Min. : 220 : 244	Min. : 208 : 232	Min. : 200 : 224	Min. : 165 : 185	Min. : 152 : 172	Min. : 132 : 152	Min. : 120 : 140	Min. : 110 : 130
14.....	Min. : 360 : 388	Min. : 348 : 376	Min. : 340 : 368	Min. : 328 : 356	Min. : 322 : 350	Min. : 316 : 344	Min. : 312 : 340	Min. : 264 : 288	Min. : 244 : 268	Min. : 232 : 256	Min. : 224 : 248	Min. : 185 : 205	Min. : 172 : 192	Min. : 152 : 172	Min. : 140 : 160	Min. : 130 : 150
15.....	Min. : 388 : 416	Min. : 376 : 404	Min. : 368 : 396	Min. : 356 : 384	Min. : 350 : 378	Min. : 344 : 372	Min. : 340 : 368	Min. : 288 : 312	Min. : 268 : 292	Min. : 256 : 280	Min. : 248 : 272	Min. : 205 : 225	Min. : 192 : 212	Min. : 172 : 192	Min. : 160 : 180	Min. : 150 : 170
16.....	Min. : 416 : 444	Min. : 404 : 432	Min. : 396 : 424	Min. : 384 : 412	Min. : 378 : 406	Min. : 372 : 400	Min. : 368 : 396	Min. : 312 : 336	Min. : 292 : 316	Min. : 280 : 304	Min. : 272 : 296	Min. : 225 : 245	Min. : 212 : 232	Min. : 192 : 212	Min. : 180 : 200	Min. : 170 : 190
17.....	Min. : 444 : 472	Min. : 432 : 460	Min. : 424 : 452	Min. : 412 : 440	Min. : 406 : 434	Min. : 400 : 428	Min. : 396 : 424	Min. : 336 : 360	Min. : 316 : 340	Min. : 304 : 328	Min. : 296 : 320	Min. : 245 : 265	Min. : 232 : 252	Min. : 212 : 232	Min. : 200 : 220	Min. : 190 : 210
18.....	Min. : 472 : 500	Min. : 460 : 488	Min. : 452 : 480	Min. : 440 : 468	Min. : 434 : 462	Min. : 428 : 456	Min. : 424 : 452	Min. : 360 : 384	Min. : 340 : 364	Min. : 328 : 352	Min. : 320 : 344	Min. : 265 : 285	Min. : 252 : 272	Min. : 232 : 252	Min. : 220 : 240	Min. : 210 : 230
19.....	Min. : 500 : 528	Min. : 488 : 516	Min. : 480 : 508	Min. : 468 : 496	Min. : 462 : 490	Min. : 456 : 484	Min. : 452 : 480	Min. : 384 : 408	Min. : 364 : 388	Min. : 352 : 376	Min. : 344 : 368	Min. : 285 : 305	Min. : 272 : 292	Min. : 252 : 272	Min. : 240 : 260	Min. : 230 : 250
20.....	Min. : 528 : 556	Min. : 516 : 544	Min. : 508 : 536	Min. : 496 : 524	Min. : 490 : 518	Min. : 484 : 512	Min. : 480 : 508	Min. : 408 : 432	Min. : 388 : 412	Min. : 376 : 400	Min. : 368 : 392	Min. : 305 : 325	Min. : 292 : 312	Min. : 272 : 292	Min. : 260 : 280	Min. : 250 : 270
21.....	Min. : 556 : 584	Min. : 544 : 572	Min. : 536 : 564	Min. : 524 : 552	Min. : 518 : 546	Min. : 512 : 540	Min. : 508 : 536	Min. : 432 : 456	Min. : 412 : 436	Min. : 400 : 424	Min. : 392 : 416	Min. : 325 : 345	Min. : 312 : 332	Min. : 292 : 312	Min. : 280 : 300	Min. : 270 : 290
22.....	Min. : 584 : 612	Min. : 572 : 600	Min. : 564 : 592	Min. : 552 : 580	Min. : 546 : 574	Min. : 540 : 568	Min. : 536 : 564	Min. : 456 : 480	Min. : 436 : 460	Min. : 424 : 448	Min. : 416 : 440	Min. : 345 : 365	Min. : 332 : 352	Min. : 312 : 332	Min. : 300 : 320	Min. : 290 : 310
23.....	Min. : 612 : 640	Min. : 600 : 628	Min. : 592 : 620	Min. : 580 : 608	Min. : 574 : 602	Min. : 568 : 596	Min. : 564 : 592	Min. : 480 : 504	Min. : 460 : 484	Min. : 448 : 472	Min. : 440 : 464	Min. : 365 : 385	Min. : 352 : 372	Min. : 332 : 352	Min. : 320 : 340	Min. : 310 : 330
24.....	Min. : 640 : 668	Min. : 628 : 656	Min. : 620 : 648	Min. : 608 : 636	Min. : 602 : 630	Min. : 596 : 624	Min. : 592 : 620	Min. : 504 : 528	Min. : 484 : 508	Min. : 472 : 496	Min. : 464 : 488	Min. : 385 : 405	Min. : 372 : 392	Min. : 352 : 372	Min. : 340 : 360	Min. : 330 : 350
25.....	Min. : 668 : 696	Min. : 656 : 684	Min. : 648 : 676	Min. : 636 : 664	Min. : 630 : 658	Min. : 624 : 652	Min. : 620 : 648	Min. : 528 : 552	Min. : 508 : 532	Min. : 496 : 520	Min. : 488 : 512	Min. : 405 : 425	Min. : 392 : 412	Min. : 372 : 392	Min. : 360 : 380	Min. : 350 : 370
26.....	Min. : 696 : 724	Min. : 684 : 712	Min. : 676 : 704	Min. : 664 : 692	Min. : 658 : 686	Min. : 652 : 680	Min. : 648 : 676	Min. : 552 : 576	Min. : 532 : 556	Min. : 520 : 544	Min. : 512 : 536	Min. : 425 : 445	Min. : 412 : 432	Min. : 392 : 412	Min. : 380 : 400	Min. : 370 : 390

As used here, urban trips are those made in cities with population of 100,000 and over and in heavily built-up suburban areas adjacent to the cities; non-urban trips are all others. When trips include stops in both urban and non-urban areas, wholesalers will need to estimate whether average driving speeds are more likely to be within the range of the urban or nonurban tables. Stop time and unloading time are similar in both urban and nonurban trips.

The studies indicated that a principal cause for excessive delivery time on a route was unnecessary delays that the drivers could have prevented. The average delivery times shown in the tables include unavoidable delays that occur in most trips, but not avoidable delays caused by the drivers.

Since the tables are based on averages, trips that are unusual should not be included. The trips that were time-studied were basically grocery deliveries to retail food stores, under normal road and weather conditions. The delivery trucks were in good operating condition; no time was allowed for delays due to delivery truck failure.

The following trips should not be included in any analysis of delivery operations:

1. Trips made in extremely bad weather.
2. Trips in which there is a truck breakdown.
3. Trips in which groceries are less than 60 percent of the merchandise carried.
4. Trips in which the deliveries are primarily to restaurants and institutions rather than retail food stores.

Using the Delivery Operation Report and the Tables

Normal delivery time can be computed directly on the delivery operation report (fig. 4) from the tables. The form is designed for a 4-week period. An example of how to complete the form and compute the delivery time is given below:

On January 10, 1961, driver J. Smith leaves the warehouse at 7 a.m. with 1,300 pieces of grocery merchandise for delivery to 3 retail stores. The odometer reading before he starts on the trip is 32,378 miles. He arrives back at the warehouse at 6 p.m., with an odometer reading of 32,588 miles. This information is recorded on the delivery operation report. The total elapsed time for the delivery was 11 hours, but the driver is allowed 30 minutes for lunch and three 10-minute coffee breaks. ^{6/} Therefore, the total actual delivery time is 10 hours. The driver traveled $32,588 - 32,378 = 210$ miles. There were 3 delivery stops, so the average distance per stop was $210 \div 3 = 70$ miles, and the average order size was $1,300 \div 3 = 433$ pieces. The trip was in a rural area; this is noted in the report.

^{6/} The drivers should always be told how much break time they are allowed. A break may be 10 or 15 minutes, as determined by the company. A schedule might be set up, specifying number of breaks for trips of various durations.

When this information is recorded, normal delivery time can be computed by using the first three tables.

First, the time for driving can be found in table 1. The total miles traveled, 210 miles, indicates that section C under "Driving time" is to be used. The average distance between stops is 70 miles. Find the proper interval under "Average distance per stop;" in this example it is "51 to 110 miles." Go down this column to the number opposite "200 to 210" under "Total miles." This number--328--is the minutes of normal driving time for the trip.

Second, the time for unloading and checking is shown in table 2. In the example the average order is 433 pieces. Under "Average order size" in the table find the correct column, which is "401 to 500 pieces." Then find the correct interval under "Total number of pieces delivered" at the left side of the table. In the example, 1,300 pieces are delivered. In the table "1,276 to 1,300" is the proper interval. Reading from that interval across the row to the column headed "401 to 500 pieces," the unloading and checking time is 180 minutes.

Third, the stop time is given in table 3. Again, "401 to 500 pieces" under "average order size" is used. Opposite the proper number of stops (3) in the left column, the stop time of 80 minutes for the trip is shown.

The normal total delivery time is, then, the sum of the three variables:

	<u>Minutes</u>
Normal travel time.....	328
Normal unloading and checking time.....	180
Normal stop time.....	<u>80</u>
Normal total delivery time.....	588

These figures are entered in the delivery operation report for comparison with the actual delivery time, which should be converted to minutes.

Tables 4, 5, and 6 can be used in the same way to find normal times for urban trips.

Individual trips should not be evaluated. The report form should provide space for a 4-week listing of trips (about 20 lines) on a single page with space at the bottom for summary and evaluation. When the trips are listed, the two columns, normal delivery time and actual delivery time, should be added and compared. The total actual delivery time should be within ± 5 percent of the total normal delivery time.

Percentage Difference Between Actual and Normal Time

Normal delivery time should be used as the base for computing the percentage difference. For example, if the normal delivery time (NDT) for the 20 trips adds up to 10,000 minutes and the actual delivery time (ADT) for these trips adds up to 10,300 minutes, the percentage difference should be computed as follows:

ADT - NDT	= Difference
Difference ÷ NDT	= % Difference
10,300 min. - 10,000 min.	= +300 min.
300 ÷ 10,000	= +3% Difference

The difference is always divided by NDT. If ADT is greater than NDT, the difference is "+"; if ADT is less than NDT, the difference is "-". In this example, the actual time was 3 percent more than the normal time, but since this is well within the ± 5 percent, the performance of the driver would be considered at standard.

If the difference were more than +5 percent, it would indicate that the driver was not performing at standard. If the difference is more than +5 percent in successive evaluations, some remedial action would probably be justified.

To evaluate the entire delivery operation, it is necessary only to compute the average percentage difference for all the drivers. If this difference is within ± 5 percent, the delivery operation is normal. If the difference is -5 percent or better, the delivery operation is probably above standard. If it is more than +5 percent, the delivery operation is below standard and some explanation should be sought. The explanation might be:

(1) The delivery operation is substantially different from any of those on which standard time is based. A careful review of the kinds of trips not included in the research would help determine whether such a difference existed.

(2) The delivery operation includes practices at the warehouse, at the start or end of the trip, unscheduled breaks during the trip, or retailer practices which require the driver to spend more time than necessary at many stops. A checklist of practices which will increase the efficiency of drivers is included in the appendix, following the case studies.

Adjustments can be made for delivery trips in which perishables are included with the grocery merchandise or backhauls are made. (In a backhaul, merchandise from a supplier is picked up and hauled back to the warehouse, usually after the driver has made his last delivery stop.)

Evaluating Trips With Backhaul

The adjustment for a backhaul should be used only on nonurban trips. It is not valid on urban trips because they are usually shorter; any delay time at the supplier may be too large a proportion of the time for the trip.

The normal time for nonurban deliveries with a backhaul can be estimated by using table 9. For this type of delivery, the number of pieces for backhaul must be recorded. Driving time, unloading and checking time, and stop time are computed in the usual way, but the loading time and stop time at the supplier must be added. The time to load merchandise is about the same as the time to unload the same number of pieces, and the stop time at the supplier is about the same as the stop time at a store for a similar quantity of merchandise.

Example: A driver delivers 1,200 pieces of merchandise to 5 stores in a nonurban area and picks up 550 pieces, after his last stop, for backhaul to the warehouse. When he arrives at the warehouse, he has traveled a total of 110 miles on the trip. The average time for this trip can be computed from table 9.

First, section B of table 9 should be used to compute driving time for a trip of 110 miles. The average distance per stop is 110 miles divided by 6 stops (including supplier stop), or 18.3 miles per stop. Section B indicates that, when the average number of miles per stop is from 12 to 25 miles, the rate of travel is 1.8 minutes per mile. Therefore, the travel time is 110 miles x 1.8 minute per mile = 198 minutes.

Second, 1,200 pieces were delivered to 5 stops. Section D is used to compute unloading time. The average order size is 1,200 pieces divided by 5 delivery stops, or 240 pieces per stop. Sections D and E indicate that, when the average order is from 201 to 300 pieces, the unloading and checking time is .180 minute per piece and the stop time is 19 minutes per stop. The unloading and checking time, then, is 1,200 pieces x .180 minute per piece = 216 minutes, and the stop time is 19 minutes x 5 stops = 95 minutes.

The loading and stop time at the supplier is then computed. Sections D and E are used again. For 501 to 600 pieces, the time for loading is .125 minute per piece, and the stop time is 28.5 minutes per stop. The additional time for the backhaul is 550 pieces x .125 minutes per piece = 68.7 minutes for loading, and 1 backhaul stop x 28.5 minutes = 28.5 minutes for stop time at the supplier.

The time for each of these elements of the delivery trip is added up for the total normal delivery time.

Travel time.....	198 minutes
Unloading and checking time.....	216 minutes
Stop time at stores.....	95 minutes
Loading time at supplier.....	69 minutes
Stop time at supplier.....	<u>28 minutes</u>
Total normal delivery time.....	606 minutes, or
	10 hours and 6 minutes

Evaluating Trips With a High Proportion of Perishables

The tables allow for a small amount of perishables (produce, frozen foods, meat) in a portion of the delivery trips. If less than 10 percent of all pieces carried on a trip are perishables, no adjustment is necessary. If over 10 percent of the merchandise is perishable items, an adjustment must be made before the tables are used. If over 40 percent is perishables, the trip should be omitted from the evaluation.

On the average, a unit of perishable merchandise (a hamper, crate, or box) requires about 30 percent more time to unload than a case of grocery merchandise. This makes possible a reasonable estimate of unloading time when more than 10 percent of the merchandise is perishable.

First, add grocery pieces to perishable pieces for total pieces delivered. Then divide the total pieces by the number of delivery stops, and determine the unloading and checking time per piece from the table.

Second, multiply the number of grocery pieces by the unloading and checking time per piece to obtain the grocery unloading time.

Third, multiply the number of perishable pieces by 130 percent. This converts the perishable pieces to grocery pieces, in terms of unloading time.

Fourth, multiply the adjusted number of perishable pieces by unloading and checking time per piece indicated in the estimating table, to obtain the unloading time for the perishables.

Then add unloading and checking time for groceries to that for perishables to get total unloading and checking time.

Example: A delivery trip has 800 grocery pieces and 250 perishable pieces for delivery to two stores. The unloading and checking time for this trip would be computed as follows:

(1) The total number of pieces for delivery is 1,050. The average per stop is $1,050 \text{ pieces} \div 2 \text{ stops} = 525 \text{ pieces}$. Section D of table 1 shows that, for average order size of 501 to 600 pieces, the unloading and checking time is .125 minute per piece. (2) Multiply the 800 grocery pieces by .125 minute for grocery unloading time ($800 \times .125 = 100 \text{ minutes}$). (3) Since over 10 percent of the load is perishable merchandise, an adjustment is necessary. Multiply 250 pieces by 130 percent ($250 \text{ pieces} \times 1.30 = 325 \text{ pieces}$). The perishables are the equivalent of 325 pieces of groceries in computing unloading time. (4) Multiply 325 pieces by .125 minute ($325 \text{ pieces} \times .125 \text{ minute} = 41 \text{ minutes}$) for unloading time of perishable items. (5) Grocery unloading time (100 minutes) plus perishable unloading time (41 minutes) equals 141 minutes, the total unloading and checking time for the trip.

CONCLUSIONS

The procedure for evaluating driver performance and overall delivery operations can contribute to improved operations in two ways: (1) It provides a standard of performance against which management can evaluate individual and company delivery operations. The standards are applicable to most grocery delivery trips for food distribution centers in different parts of the country serving different types of retailers. Problem areas in the delivery operation can be isolated, and changes made to increase efficiency can be evaluated. (2) It makes delivery personnel aware of management's interest in their performance and management's knowledge of how well they are doing. These factors, together with continuing efforts to better the performance, are likely to achieve positive results.

The procedure measures the efficiency of delivery personnel. If it is used in conjunction with changes to reduce delivery costs, such as reducing the number of delivery trips and improving the routing to shorten miles traveled, the full potential of the changes can be more nearly realized.

Improved practices often do not result in lower costs because the time saved in the performance of an operation is not used productively. With this procedure, management has a standard by which to judge each driver's performance before and after the adoption of new practices.

For firms that operate more than one warehouse this procedure offers a way of making meaningful comparisons in terms of percentage difference from the normal delivery time.

APPENDIX

Methodology

A total of 120 delivery trips in all parts of the country were time-studied. On these trips, over 80,000 pieces of merchandise were delivered to 1,400 retail food stores, and over 10,000 miles were traveled. The procedure used to analyze the data is illustrated in a case study of eight delivery trips by one company.

The company is a progressive wholesaler in a large southern city, serving small retailers within a 100-mile radius. Sizes of the orders time-studied at this company ranged from about 20 to 200 pieces per delivery stop. A total of 14 delivery trips were studied. Table 7 shows a summary of the time studies of eight of these trips.

Preliminary analysis showed how certain variables affected each of the principal parts of a delivery trip. Driving time varies with distance between stops and total miles traveled. Unloading and checking time varies directly with order size, and stop time varies inversely with order size. When these relationships were verified, the time study data were put in table 8, in which the average number of miles between stops and the average order size were computed. Driving time in minutes per mile and unloading time per piece were computed. The average time per stop for other productive activities was also computed. This is referred to as stop time. The time study data were then charted from the information in table 8.

Each of the 120 trips was analyzed in this way and used to make figures 1 to 3. In the chart for unloading and checking time (fig. 2), the time per piece was computed and charted against the average order size. This was done with each time study to form scatter diagrams like figure 5. In this figure eight of the time studies have been charted. They appear below the line which represents the average of all the time studies made as part of this research.

Formulas for Estimating Normal Delivery Time

Tables 9 and 10 describe the multiplication processes by which normal times for the three major variables can be found. Tables 1 to 6, in which the multiplications were carried out for various total distances, order sizes, and numbers of stops, were constructed directly from tables 9 and 10.

Here is the way to use table 9 with the example in the section on "Using the Delivery Operation Report":

Table 7.--Data collected in time studies of 8 delivery trips by a wholesale grocery firm 1/

Item	Trip number							
	1	2	3	4	5	6	7	8
<u>Unload and check time:</u>								
Move merchandise to tailgate.....Min.:	114.42	72.53	33.29	74.84	73.20	88.21	50.83	82.84
Stack cases on handtruck.....do.:	43.56	31.21	23.53	15.34	15.12	10.82	38.31	1.82
Move merchandise to storage and return.....do.:	106.80	86.47	37.76	53.18	44.37	27.32	62.78	28.77
Retailer checks order.....do.:	43.09	51.66	25.06	51.96	35.93	79.55	33.30	43.57
Unload frozen food.....do.:	41.50	52.86	15.35	24.17	15.53	11.85	15.52	18.20
Total.....do.:	349.37	294.73	134.99	219.49	184.15	217.75	200.74	175.20
<u>Number of pieces unloaded.....Pcs.:</u>								
Frozen food pieces unloaded.....Pcs.:	950	686	274	458	506	841	464	401
	125	100	26	51	42	30	31	37
<u>Travel time:</u>								
Drive time from warehouse and return.....Min.:	252.94	248.84	204.94	310.24	196.72	187.44	338.51	262.97
Position truck.....do.:	2.75	3.70	4.53	4.01	6.85	2.99	3.06	3.44
Total.....do.:	255.69	252.54	209.47	314.25	203.57	190.43	341.57	266.41
Total distance traveled.....Mi.:	149	150	78	194	114	97	204	97
<u>Stop time (other productive activities):</u>								
Read order.....Min.:	17.50	16.58	10.42	9.21	16.39	18.93	19.75	16.35
Walk to rear of truck.....do.:	8.64	7.81	5.26	4.78	5.84	4.50	8.04	5.84
Position conveyor.....do.:	1.04	1.66	.93	.61	1.36	.68	2.39	1.01
Close doors.....do.:	6.73	6.41	3.12	5.23	4.75	2.40	8.33	2.25
Walk to cab and start engine.....do.:	3.69	6.51	2.82	3.16	4.35	2.74	4.98	2.17
Walk from warehouse to truck.....do.:	.85	.75	.98	.92	.96	.73	.46	.60
Read for route.....do.:	1.00	.45	.33	.85	.79	2.20	1.52	2.02
Collect for c.o.d.....do.:	6.87	17.90	11.33	1.18	18.49	10.84	9.35	29.96
Retailer signs order.....do.:	4.90	3.73	3.51	3.95	2.68	3.75	6.88	4.36
Unavoidable delays.....do.:	14.63	9.38	14.75	11.35	10.68	18.04	31.85	23.40
Total.....do.:	65.85	71.18	53.45	41.24	66.29	64.81	93.55	87.96
Number of delivery stops.....Stops:	18	10	12	6	16	5	20	9
Total delivery time.....Min.:	670.91	618.45	397.91	574.98	454.01	472.99	635.86	529.57

1/ In this research similar data were collected for a total of 120 trips.

Table 8.--Analysis of time study data for 8 delivery trips by a wholesale grocery firm 1/

Trip no.	Total : delivery : time	Total : miles : traveled	Total : driving : time	Driving : time : per mile	Average : miles : per stop	Total : pieces : Total	Unload and : check time : Total	Average : pieces : per stop	Stops	Stop time (other : productive : activities)
	: Min. : 670.91	: Miles : 149	: Min. : 255.69	: Min. : 1.716	: Miles : 8.3	: No. : 1,075	: Min. : 349.37	: Min. : .325	: No. : 18	: Total : Per stop
1.....										3.658
2.....	618.45	150	252.54	1.683	6.8	786	294.73	.375	79	71.18 3.235
3.....	397.91	78	209.47	2.685	6.5	300	134.99	.450	25	53.45 4.454
4.....	574.98	194	314.25	1.620	32.3	509	219.49	.431	85	41.24 6.873
5.....	454.01	114	203.57	1.786	7.1	548	184.15	.336	34	66.29 4.143
6.....	472.99	97	190.43	1.963	8.8	871	217.75	.250	174	64.81 5.892
7.....	635.86	204	341.57	1.674	10.2	495	200.74	.405	25	93.55 4.677
8.....	529.57	97	266.41	2.746	4.8	438	175.20	.400	49	87.96 4.398

1/ In this research similar analyses were made for a total of 120 trips.

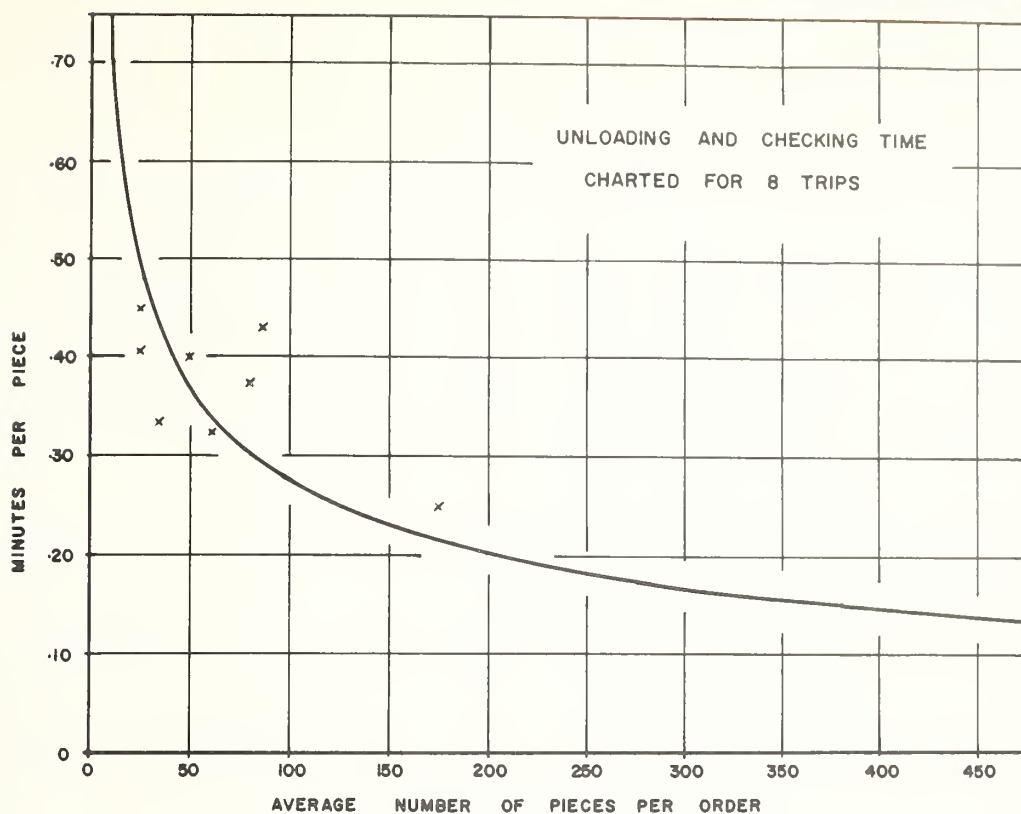
Table 9.--Nonurban delivery trips by wholesale grocery firms: Formulas for estimating total time required

Driving time					D--unloading and checking time		E--Stop time
A--for trips of 90 miles or less		B--for trips of 91 to 200 miles		C--for trips of more than 200 miles	Average order size	Average time per piece (multiply by total pieces delivered)	Average time per stop (multiply by total number of stops made)
Average distance per stop	Average time to travel 1 mile (multiply by total miles traveled)	Average distance per stop	Average time to travel 1 mile (multiply by total miles traveled)	Average distance per stop	Average time to travel 1 mile (multiply by total miles traveled)		
<u>Miles</u>	<u>Min.</u>	<u>Miles</u>	<u>Min.</u>	<u>Miles</u>	<u>Min.</u>	<u>Pieces</u>	<u>Min.</u>
Under 5.0	3.0	Under 5.0	2.7	12.1 to 25	1.8	10 to 25	2.8
5.1 to 6.0	2.7	5.1 to 6.0	2.3	26 to 50	1.7	26 to 50	3.5
6.1 to 8.0	2.5	6.1 to 8.0	2.1	51 to 110	1.6	51 to 75	6.0
8.1 to 11.0	2.4	8.1 to 12.0	1.9	Over 110	1.5	76 to 100	10.0
Over 11.0	2.3	12.1 to 25	1.8			101 to 125	13.5
		26 to 50	1.7			126 to 200	16.0
		Over 50	1.6			201 to 300	19.0
						301 to 400	24.0
						401 to 500	26.5
						501 to 600	28.5
						601 to 700	30.5
						701 to 1,000	32.0
						Over 1,000	32.0

Table 10.--Urban delivery trips by wholesale grocery firms: Formulas for estimating total time required

A--Driving time		B--Unloading and checking time		C--Stop time
Average distance per stop	Average time to travel 1 mile (multiply by total miles traveled)	Average order size	Average time per piece (multiply by total pieces delivered)	Average time per stop (multiply by number of delivery stops)
<u>Miles</u>	<u>Minutes</u>	<u>Pieces</u>	<u>Minutes</u>	<u>Minutes</u>
Under 1	8.8	Under 15	0.750	3.0
1.0 to 1.5	7.0	16 to 20	.650	4.0
1.6 to 2.0	4.8	21 to 25	.525	5.0
2.1 to 3.0	4.0	26 to 30	.475	6.0
3.1 to 4.0	3.5	31 to 50	.410	7.0
Over 4.0	3.4	50 to 70	.335	9.0
		71 to 100	.290	12.0
		101 to 150	.245	16.0
		151 to 250	.200	17.0
		251 to 350	.165	18.0
		351 to 450	.150	19.0
		451 to 650	.125	20.0
		651 to 850	.110	21.0
		Over 850	.100	22.0

Example: For an urban delivery trip of 60 miles to 6 stores in which 660 pieces are delivered, the standard delivery time would be computed as follows: Driving time--Determine the average distance between stops; for this trip it is 10 miles (60 miles divided by 6 stops). Part A shows that for trips in which the average distance per stop is over 4.0 miles the driving time is 3.4 minutes per mile. The total driving time is 204 minutes (60 miles x 3.4 minutes). Unloading and checking time--Determine the average order size by dividing total pieces by the number of delivery stops. For this trip the average order is 110 pieces (660 pieces divided by 6 stops). Look up 110 pieces in part B. For average orders of 101 to 150 pieces, the unloading and checking time per piece is .245 minute. The total unloading and checking time is 162 minutes (.245 minute x 660 pieces = 161.7 minutes). Stop time--The average order size is used to determine stop time, also. For average orders between 101 and 150 pieces the stop time (part C) is 16.0 minutes per stop. For a trip with 6 delivery stops, the stop time is 96 minutes (16.0 minutes x 6 stops). Therefore, the total delivery time is 204 + 162 + 96 = 462 minutes, or 7 hours and 42 minutes.



U. S. Department of Agriculture

Neg. AMS 20-61(6) Agricultural Marketing Service

Figure 5.--Relationship between average number of pieces per order and unloading and checking time for 120 trips (8 trips charted).

First, the time for driving is computed. The total miles traveled determines which section under "Driving time" is to be used. In this example, the total distance traveled is 210 miles. Therefore, section C should be used to compute driving time. The proper interval in that section is determined by the average miles per stop, which is listed as 70 miles in the delivery operation report.

Since 70 miles per stop is in the interval of 51 to 110 miles, the driving time is 1.6 minutes per mile. The total distance (210 miles) is then multiplied by 1.6 minutes per mile, resulting in the normal travel time of 336 minutes for the trip. 7/

Second, the time for unloading and checking merchandise is computed. Section D of table 9 lists the average time to unload one piece of merchandise for orders of different sizes. The data for this section were taken directly from figure 1. In this example, the average order size is 433 pieces. In section D, this number is within the interval of 401 to 500 pieces, for which

7/ Driving time calculated by this method is slightly different from that given in table 1 for this example. The multiplications in table 1 were performed on the midpoints of the intervals. In this case the midpoint was 205 miles.

the unloading and checking time is .140 minute per piece. On this trip, 1,300 pieces were delivered. The unloading and checking time of .140 minute per piece, multiplied by 1,300 pieces, results in a normal unloading and checking time of 182 minutes. 8/

Third, the stop time is computed. Since this also varies with the order size, it can be computed at the time the unloading and checking time is computed. When the average order is 401 to 500 pieces, the time for making stops is 26.5 minutes per stop. This is multiplied by the number of stops. In this example, there are 3 stops; the normal stop time is $26.5 \times 3 = 79.5$ or 80 minutes.

The normal total delivery time is, then, the sum of the result of these three variables:

	<u>Minutes</u>
Normal travel time.....	336
Normal unloading and checking time.....	182
Normal stop time.....	<u>80</u>
Total normal delivery time.....	598

Table 10 can be used in the same way for urban trips. An example is given immediately below the table.

Case Studies

Typical Delivery Operation

Company A is a full-line wholesaler, with an annual volume of \$64 million, serving about 600 retail food stores in the Memphis, Tenn., area. The grocery department also delivers frozen foods, health and beauty aids, and cigarettes. Produce is seldom delivered with grocery orders.

A total of 29 drivers are employed by the firm to drive 27 delivery trucks. No night deliveries are made by the grocery department, and trailers are not dropped at the stores.

To evaluate the grocery delivery operation, 176 urban and nonurban trips were analyzed. The urban and nonurban trips are combined in table 11 since no difference was found.

About 40 trips were analyzed each week for 4 weeks (table 11). On the average, the actual delivery time was found to be about 9 percent more than the normal delivery time. In the 4-week period of the analysis, the actual delivery time was 2,105 hours, while the normal delivery time was 1,933 hours, a difference of 172 hours. If the firm could attain normal delivery time, it would save over 40 hours per week.

8/ Table 2 gave a slightly different time because the multiplication was performed on 1,288 pieces, the midpoint of the interval.

Table 11.--Total delivery time, 4 groups of urban and nonurban trips made by company A

Group	Normal	Actual	Difference from normal	Percent difference from normal
	<u>Minutes</u>	<u>Minutes</u>	<u>Minutes</u>	<u>Percent</u>
1.....	28,335	29,770	+1,435	+5.1
2.....	29,130	32,390	+3,260	+11.0
3.....	29,140	32,160	+3,020	+10.3
4.....	29,384	32,000	+2,616	+9.0
Total..	115,989	126,320	+10,331	+8.9
	(1,933 hr.)	(2,105 hr.)	(+172 hr.)	

Delivery Operation With Backhaul

Company B is a dry grocery wholesaler with an annual volume of \$13 million, operating in and around Tulsa, Okla. Of the 200 stores served, about 25 percent are supermarkets. About 10 percent of the volume is from institutions such as restaurants, schools, and hospitals.

The company handles and delivers frozen foods and cigarettes, but not produce, meats, or other perishables. The company operates 19 delivery trucks and employs 18 drivers. It does not make night deliveries and does not drop trailers at retail stores. The trucks make frequent backhauls.

An analysis of 100 rural trips without backhauls and 45 rural trips with backhauls indicated that all rural trips compared favorably with normal delivery time (table 12). The rural trips without a backhaul were analyzed in 5 groups of 20 trips each. The actual delivery time for 5 groups was 3.4 percent more than the normal delivery time for these trips. This is within the 5 percent standard deviation.

Table 12.--Total delivery time, 5 groups of nonurban trips without backhaul by company B

Group	Normal	Actual	Difference from normal	Percent difference from normal
	<u>Minutes</u>	<u>Minutes</u>	<u>Minutes</u>	<u>Percent</u>
1.....	11,285	11,790	+505	+4.5
2.....	12,926	13,230	+304	+2.3
3.....	12,783	13,170	+387	+3.0
4.....	12,003	11,520	-483	-4.0
5.....	11,958	13,320	+1,362	+11.3
Total..	60,955	63,030	+2,075	+3.4
	(1,016 hr.)	(1,050 hr.)	(+34 hr.)	

The nonurban trips with backhauls were analyzed in 3 groups of 15 trips each (table 13). The actual delivery time was 2.8 percent more than the normal delivery time. The normal delivery time for each trip with a backhaul was computed in the way described in the section on methodology, at the beginning of the appendix.

Table 13.--Total delivery time, 3 groups of nonurban trips with backhaul by company B

Group	Normal	Actual	Difference from normal	Percent difference from normal
	Minutes	Minutes	Minutes	Percent
1.....	9,110	9,540	+430	+4.7
2.....	11,675	11,940	+265	+2.2
3.....	11,529	11,730	+201	+1.7
Total:	32,314	33,210	+896	+2.8
	(538 hr.)	(553 hr.)	(15 hr.)	

About 42 urban trips were analyzed. The actual delivery time was about 20 percent more than the normal delivery time for these trips.

Delivery Operation With High Proportion of Small Stores

Company C is a dry grocery wholesaler serving about 300 stores in a radius of 150 miles from Springfield, Mass. The annual volume is over \$27 million, with less than 5 percent of the business from institutional establishments. Health and beauty aids and some soft goods are delivered with groceries. The company does not handle cigarettes or perishables. Less than 15 percent of the stores served are supermarkets (sales over \$1 million annually).

The company employs 25 delivery drivers, and operates 12 straight trucks or vans and 10 tractor-trailers. The trailers are 32 and 36 feet long and are sometimes dropped at the larger stores.

In the evaluation, 30 urban delivery trips were analyzed in 2 groups of 15 trips each (table 14), and 40 nonurban trips were analyzed in 2 groups of 20 trips each (table 15). In the urban trips the time was better than normal. In the first group the actual delivery time was 5 percent less than the normal delivery time. In the second group, the actual time was 2/10 of 1 percent less than the normal time.

Table 14.--Total delivery time, 2 groups of urban trips made by company C

Group	Normal	Actual	Difference from normal	Percent difference from normal
	Minutes	Minutes	Minutes	Percent
1.....	6,681	6,307	-374	-5.6
2.....	7,385	7,365	-20	-0.2
Total:	14,066	13,672	-394	-2.8
	(234 hr.)	(228 hr.)	(7 hr.)	

In the first group of nonurban trips the actual delivery time was 17.5 percent more than the normal time. In the second group the actual time was 20.3 percent more than the normal time.

Table 15.--Total delivery time, 2 groups of nonurban trips made by Company C

Group	Normal	Actual	Difference from normal	Percent difference from normal
	Minutes	Minutes	Minutes	Percent
1.....	7,569	8,895	+1,326	+17.5
2.....	8,802	10,590	+1,788	+20.3
Total..	16,371	19,485	+3,114	+19.0
	(273 hr.)	(325 hr.)	(52 hr.)	

Delivery Operations of Two Divisions of One Company

Company D is a full-line wholesaler operating several divisions in the Southwest. Analysis of two divisions indicated that one division was operating in normal delivery time while the other was taking 25 to 30 percent more than normal time.

Division 1

Division 1 serves about 80 stores, 45 of which are supermarkets. It has an annual volume of over \$33 million. It does not serve any institutions or restaurants.

Produce, meat, frozen foods, health and beauty aids, and cigarettes are often delivered with groceries. The division operates 22 tractors, 32 trailers, and 2 straight trucks, and employs 22 drivers.

A total of 135 nonurban trips from division 1 were analyzed in 7 groups, (table 16). The total actual delivery time for each group ranged from 22 percent to 41 percent more than the total normal delivery time. Normal time is 318 hours less than the actual time for these trips. If these trips were completed in normal time, a saving of about 80 hours a week would result.

Table 16.--Total delivery time, 7 groups of nonurban trips made by division 1, company D

Group and number of trips	Normal	Actual	Difference from normal	Percent difference from normal
	Minutes	Minutes	Minutes	Percent
1 (20).....	10,619	13,335	+2,736	+25.8
2 (20).....	9,066	12,090	+3,024	+33.4
3 (20).....	11,201	14,580	+3,379	+30.2
4 (15).....	6,298	8,910	+2,612	+41.5
5 (20).....	11,064	13,545	+2,481	+22.4
6 (20).....	8,817	11,265	+2,448	+27.8
7 (20).....	10,683	13,050	+2,367	+22.2
Total (135)..	67,748	86,795	+19,047	+28.1
	(1,129 hr.)	(1,447 hr.)	(+318 hr.)	

The urban trips for this division take about 34 percent more than the normal delivery time in an analysis of 80 such trips (table 17). The total actual time for these trips was 392 hours compared to the normal time of 292 hours.

Table 17.--Total delivery time, 4 groups of urban trips made by division 1 company D

Group	Normal	Actual	Difference from normal	Percent difference from normal
	<u>Minutes</u>	<u>Minutes</u>	<u>Minutes</u>	<u>Percent</u>
1.....	4,150	6,215	+2,065	+49.8
2.....	4,405	5,505	+1,100	+22.4
3.....	4,225	5,365	+1,140	+27.0
4.....	4,660	6,420	+1,760	+37.8
Total.....	17,440	23,505	+6,065	+34.8
	(291 hr.)	(392 hr.)	(+101 hr.)	

Division 2

Division 2 has a volume of about \$26 million annually. About half of the 70 stores served are supermarkets. No institutional outlets are served. Produce is not delivered with grocery merchandise, but health and beauty aids and soft goods are often delivered. The division employs 25 drivers and operates 12 tractors, 18 trailers, and 2 straight trucks.

In evaluating the operation 137 nonurban trips were analyzed (table 18). The actual delivery time of these trips compared favorably with normal time, with an average difference of 2.9 percent.

Table 18.--Total delivery time, 7 groups of nonurban trips made by division 2, company D

Group	Normal	Actual	Difference from normal	Percent difference from normal
	<u>Minutes</u>	<u>Minutes</u>	<u>Minutes</u>	<u>Percent</u>
1.....	8,205	8,109	-96	-1.1
2.....	9,146	9,930	+784	+8.6
3.....	7,162	7,215	+53	+0.7
4.....	8,479	8,745	+266	+3.1
5.....	7,695	7,815	+120	+1.6
6.....	8,404	8,580	+176	+2.1
7.....	6,899	7,225	+326	+4.7
Total.....	55,990	57,619	+1,629	+2.9
	(933 hr.)	(960 hr.)	(+27 hr.)	

The actual delivery time for 80 urban trips was 6 hours, or 2.8 percent less than the normal delivery time (table 19).

Table 19.--Total delivery time, 4 groups of urban trips made by division 2, company D

Group	:	Normal	:	Actual	:	Difference	:	Percent difference
	:		:		:	from normal:	:	from normal
	:	<u>Minutes</u>	:	<u>Minutes</u>	:	<u>Minutes</u>	:	<u>Percent</u>
1.....	:	3,187	:	3,295	:	+108	:	+3.3
2.....	:	3,439	:	3,175	:	-264	:	-7.7
3.....	:	3,857	:	3,555	:	-302	:	-7.8
4.....	:	3,155	:	3,230	:	+75	:	+2.4
Total.....	:	13,638	:	13,255	:	-383	:	-2.8
	:	(227 hr.)	:	(221 hr.)	:	(-6 hr.)	:	

Checklist of Practices to Increase Efficiency

1. Is each truck provided with delivery equipment that is in good working order? Do trucks carry conveyors for deliveries to stores that accommodate conveyor unloading?
2. In metropolitan areas, where several stops are made on a delivery trip, is the truck size in keeping with the loads carried and the traffic and parking problems encountered? In congested areas, large straight trucks and trailers require more time for driving and parking.
3. Have the possibilities of side doors on the trucks been fully explored? If deliveries are made to many stores which have poor receiving facilities or locations, a side door or doors can save considerable parking and unloading time.
4. Are retailers fully informed about delivery costs and the cost of unnecessary delays at the store?
5. Are drivers given productive tasks when they return from a short delivery trip? When trips are less than 8 hours, drivers may delay their return to avoid doing the work of a porter or "make-work" activities. When the driver returns from a delivery before the end of the work day he should be assigned duties related to the delivery operation, such as care of his vehicle, or preparing for the next trip.
6. Do the drivers know about management's continuing efforts to improve delivery operations? If the delivery personnel believe management has little interest or control, they may become lax; on the other hand, their efforts are buoyed up when management is "on top" of the operation.
7. Are delivery trucks leaving the warehouse too early for the first stop? A delay will result if the truck arrives at the first stop before the store opens.
8. Are routings kept current? Do they take into account new roads and road construction? Errors in routing may cause drivers to lose considerable time. Drivers are often more familiar with the exact locations of some stops and with changes in streets and highways than the dispatcher can be. The driver

can be asked to note on his manifest any routing problems or backtracking on the day's delivery trip.

9. Is an effective system of separating merchandise used? If the driver must sort out merchandise at each stop, the unloading time is greatly increased. Some wholesalers use nets to separate orders. Others write the stop numbers on the last row of merchandise that goes to each delivery stop; if this method is used, care should be taken that only one number appears on a case.

10. Are delivery trips balanced to avoid overtime? If one trip is likely to be 10 or 12 hours and another trip only 4 or 5 hours, it may be more economical to shift some of the stops to the shorter delivery trip, even though the total mileage of the two trips would be increased. This may also save a trip to a store that closes early.

11. Is the driver using unavoidable delay time productively? Some unavoidable delays occur on most delivery trips. During delays, the driver can move merchandise to the tailgate, arrange merchandise so it will be secure on route, or do necessary paper work. On some trips this would save up to 10 percent of the time. Drivers may be encouraged to take their lunch and coffee breaks during delay periods.

12. Is the driver using store help effectively? When help is provided at the store, the driver should move the load to the tailgate while the helper moves it from the tailgate into the store. Drivers should help store personnel check merchandise when an item check is required.



Growth Through Agricultural Progress

